RWE

How is a wind turbine constructed?

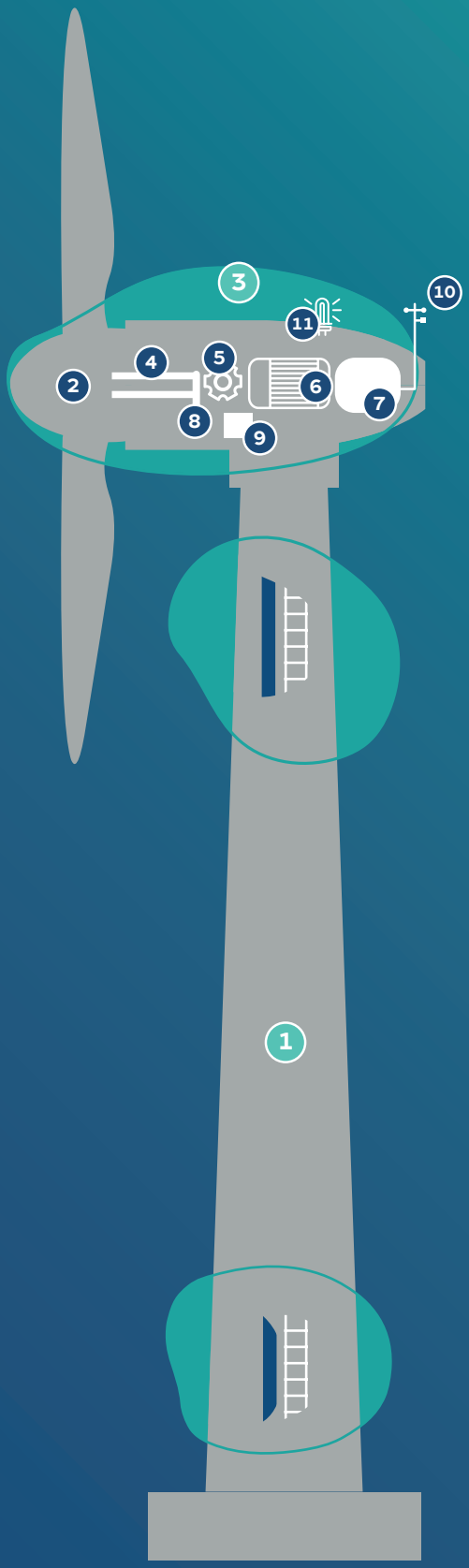
A wind turbine consists of several main components:

The tower (1) is usually a tubular construction made of prefabricated sections assembled on site and can reach a height of **up to 170 metres.** It has a dual function: **it absorbs the vibrations caused by the rotation of the rotor blades and supports both the rotor and the nacelle.**

The rotor (2) consists of three blades that are attached to a pivot point, the so-called hub. The **angle of the blades can be adjusted relative to the wind** with the help of a control mechanism known as **pitch control.** As a result, blades start to harvest the kinetic energy.

The nacelle (3) forms the upper part of the wind turbine and houses the key components used to convert mechanical energy to electrical energy. They include **the drive shaft** (4), **gearbox** (5), **generator** (6), **transformer** (7), **braking system** (8) **and the yaw control system** (9), which controls the orientation of the turbine around its vertical axis, thereby aligning the rotor with the optimum wind direction.

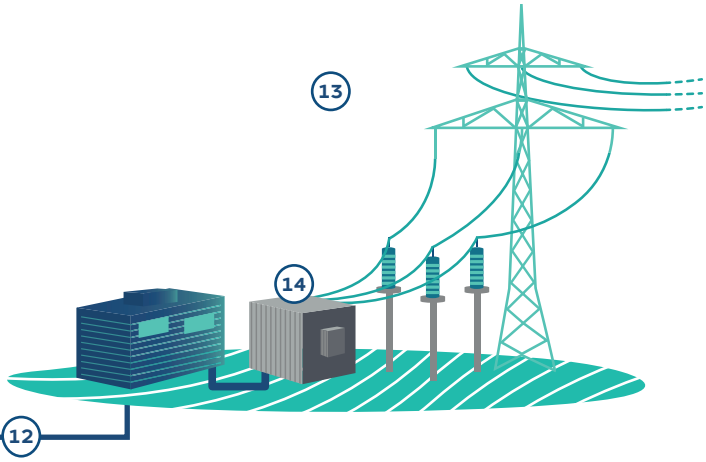
The anemometer (10), is located on the nacelle and measures the wind speed and direction, thus optimising the performance of the system. **Aviation warning lighting** (11) uses flashing lights to alert aircraft to the presence of the wind turbine and ensure safety within the airspace.



Main components of a wind turbine

1. Tower
2. Rotor
3. Nacelle
4. Drive shaft
5. Gearbox
6. Generator
7. Transformer
8. Braking system
9. Yaw control system
10. Anemometer
11. Aviation warning lighting

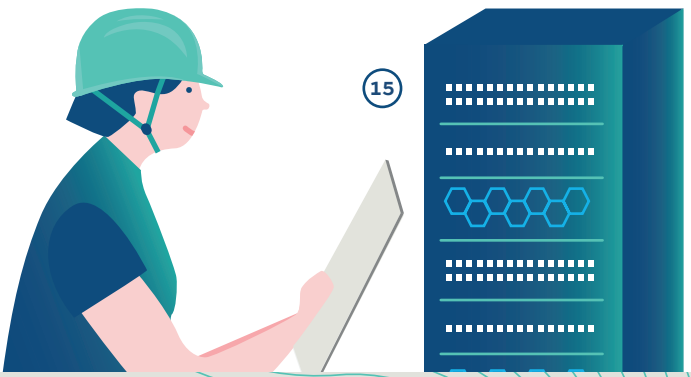
A wind farm is made up of a series of wind turbines connected to each other by underground **medium-voltage cables** (12)**.** The electricity generated is then usually converted to high voltage in a **substation** (13) using a **transformer** (14) before being fed into the transmission or distribution grid.



Wind turbine

(12) **Medium-voltage cables**
(13) **Substation**
(14) **Transformer**
(15) **SCADA**

The supervisory control and data acquisition system, known as **SCADA** (15), is housed in the substation or sometimes in the wind farm itself. This system enables **real-time monitoring of turbine operation** and outage management, including remotely.



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How does a wind turbine work?

Wind turbines convert the kinetic energy of the wind to mechanical rotational energy, which, in turn, is converted to electrical energy.

Inside the wind turbine, mechanical energy is converted to electrical energy, which is then fed into the public power grid.

As soon as the **wind speed** (1) (kinetic energy) reaches the minimum starting threshold of about **3 metres per second (m/s), the three-bladed rotor** (2) switches from idle to operational mode and converts the kinetic energy to mechanical energy. The rotor speed increases in proportion to the wind speed until it reaches its **maximum threshold at about 25 m/s.**

The rotor is connected to **the nacelle** (3) via **the drive shaft** (4)**, which rotates at the same speed as the blades** (max. 16 revolutions per minute).

The mechanical energy is first amplified by a **speed multiplier** (5) (by a factor of around 100) and then transferred to **the generator** (6)**,** in which the **mechanical energy is converted to electrical energy** with the help of a magnetic system.

The generator produces low-voltage electricity, which is then increased to medium voltage by the turbine's **transformer** (7)**.**

Components of wind turbine operation

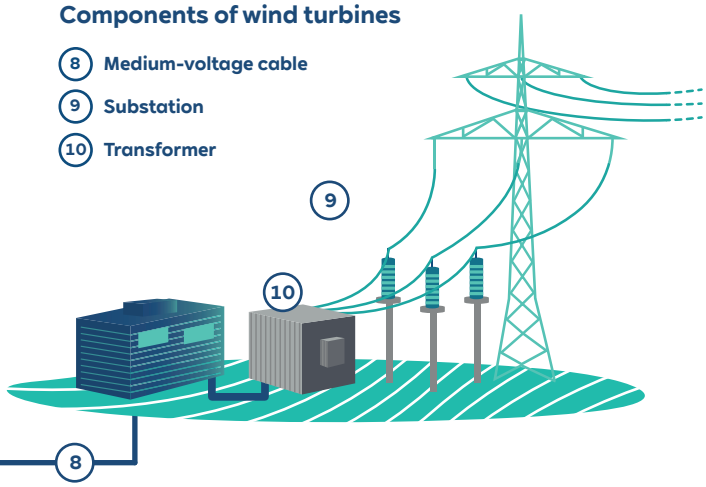
(1) Wind speed
(2) Three-bladed rotor
(3) Nacelle
(4) Drive shaft
(5) Speed multiplier
(6) Generator
(7) Transformer
(8) Medium-voltage cable

The electricity generated by the wind farm's turbines is routed via an **underground cable** (8) to a **substation** (9) connected to the transmission network. There, the electricity is converted to high voltage with the help of a **transformer** (10) and is fed into the grid.

That is how wind farms use wind to generate electricity in a sustainable way.

Components of wind turbines

(8) Medium-voltage cable
(9) Substation
(10) Transformer



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How is a wind turbine erected?

First, the infrastructure required for the transport and installation of the components is created.

The key infrastructure components include **the foundations of the wind turbines, the crane hardstands and the access roads inside and outside the wind farm.**

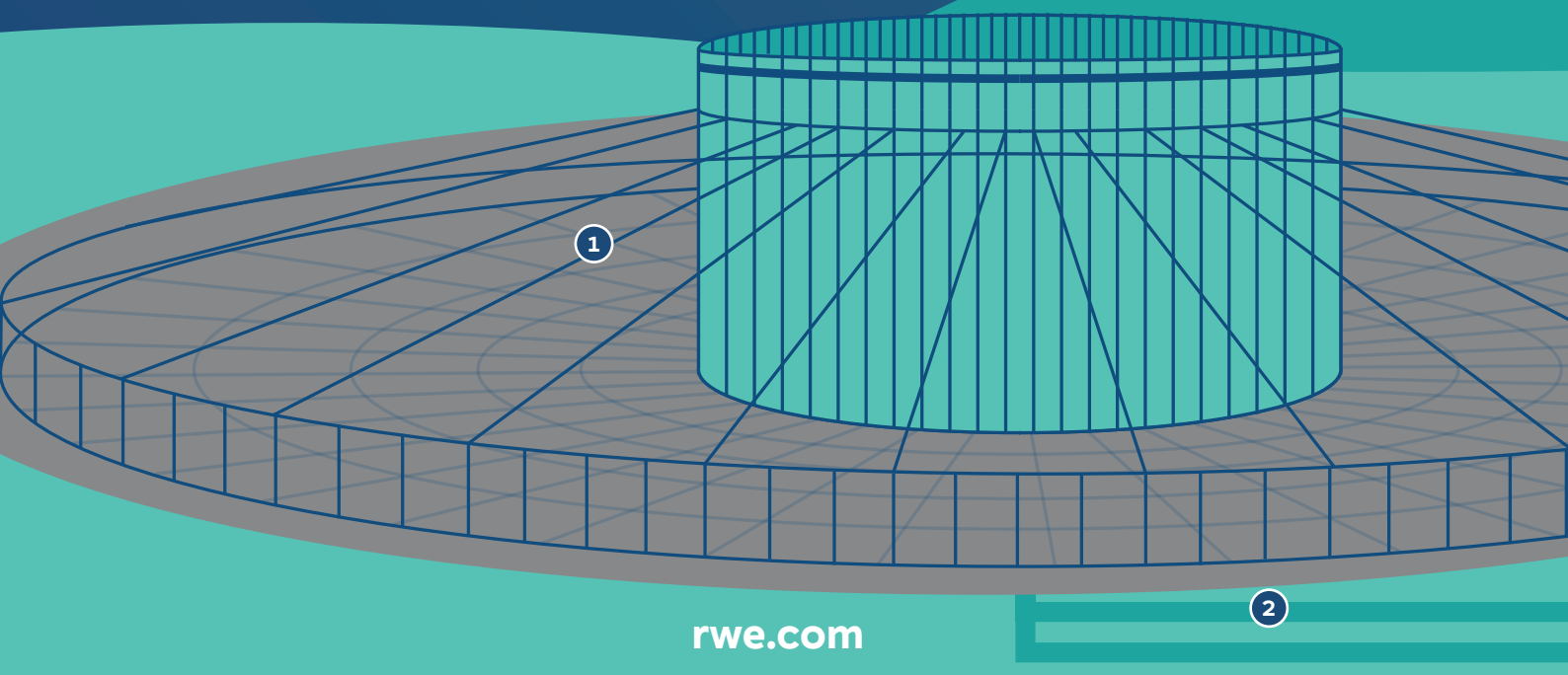
The **foundations** (1) are usually built using a steel anchor system, known as an **anchor cage,** which is attached to the foundations; both are then covered with concrete.

Empty conduits are laid in the foundations to allow **electrical cables and optical fibre** (2) to pass through.

Components of the wind turbine

(1) **Foundations**

(2) **Electric cable and optical fibre installation**



For the erection of the wind turbine, **crane hardstands** (3) are used to store components and to erect cranes for turbine assembly. The areas are about 5,000 to 10,000 square metres in size, and the **cranes** (4) can lift loads of over 100 metric tons to a height of up to 170 metres – comparable to a 45-storey high-rise building.

The tower (5) is constructed from several segments that are placed on the foundations and then connected using a crane. **The nacelle** (6), which houses all of the main technical components, is then lifted onto the tower.

The rotor blades (7) are mounted on **the hub** (8), one after the other, and are fixed in place with the help of a crane.

Transporting the main components of a wind turbine is **a logistical feat.** Parts such as the nacelle and tower segments weigh as much as **60 medium-sized cars.** The blades are also incredibly large – **they can be 70 to 80 metres long,** roughly the size of a football pitch.

In order to protect the environment and prevent interventions such as the clearing of trees, innovative technologies such as the **"Blade Lift"** (9) are used. During transport, this technology allows the blades to be tilted up to 80° through the use of hydraulics. As a result, they can be transported through narrow streets and require less space, which is particularly useful on winding roads.

Components of the wind turbine

(3) Crane hardstand
(4) Crane
(5) Tower
(6) Nacelle
(7) Rotor blades
(8) Hub
(9) "Blade Lift"